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ABSTRACTS

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Computer Code ASTRA for Nonlinear Problems in Continuum Mechanics.

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Abstract.

Interactive computer code "ASTRA" is written as convenient tool for calculation of 1–3D problems in nonlinear continuum mechanics.

1. Problems

Arbitrary Lagrangian–Eulerian moving coordinates description of motion of deformable solid, fluid and gas mediums are presented in code ASTRA.

The next **problem classes** are available:

–Dynamics and quasi–statics of elasto–visco–plastic solids with contact and failure.

–Nonlinear waves and failure in multiblock and multilayer composite medium.

–Nonlinear filtration of viscous liquid in elasto–plastic media.

–Unsteady flows of viscous incompressible fluid in complex regions.

–Unsteady flows of viscous compressible gas in complex regions.

–Unsteady shallow water flows (tidal , tsunami waves, waves caused by dipped body motion).

2. Methods

Computer code ASTRA is based upon Bubnov–Galerkin finite element method using linear and bilinear finite element approximation for space coordinates. Quasi–second order explicit, explicit–implicit and implicit differential schemes are implemented for time integration. Algebraic problems in case of implicit schemes are solved by conjugate gradient method without use of any matrices. It gives a great profit in computer random access memory and accentually simplifies the code. Contact interactions are calculated using the Lagrange multipliers method (in explicit schemes) and the penalty method (in implicit schemes) . Accuracy and stability of solution in the presence of shock waves and convection are provided by artificial correction fluxes.

3. About code

Code ASTRA works on IBM PC–386/87/25/4M (Moscow), Sun/10,HP/700 (Göteborg). Special code is written for vector acceleration device. Total size of code equals approximately 50 000 Fortran, C and Assembler strings. Problem code is written using Fortran and it is the same for different computers and compilers. Problem code is opened for modification and development. Low level software of ASTRA (graphic package, hardware interface, menus

support, low level pre– and post– processing) is represented by object libraries with user's manual, source code is hidden. Code ASTRA can be used by researchers and students specialized in nonlinear mechanics of continuous media.

3. Low level components of ASTRA .

Convenience of ASTRA for numerical experiments is provided by the next components:

Manager for problem classes and methods. Easy incorporation of new ones into ASTRA.

Total on–line help. and pop–up menus. Easy programming of new scenes of dialog interaction with user. Wide set of service input–output routines.

Editor for geometrical and physical initial data with user defined on–line help for keywords. Run–time check of correctness of initial data with clear diagnostics. Initial data sets manager.

Pre–processors for generation of finite element grids for two and three dimensional regions.

Debugger for tracing and run–time symbolic manipulation with data base.

Post–processor for graphic run–time presentation of the results for any kind of graphs. Rich set of low level routines for any kind of graphic operations.

Picture manager for manipulation of pictures (movies, conservation , hard copy , etc.).

4. Examples of results.

For each of problem classes the mostly interesting examples will be shown.

References.

Basic formulations, methods and results are described in [1–2]. There are also presented some references to other Russian papers devoted to ASTRA during 1979–1993.

1. Burago N.G., Kukudzjanov V.N. "Solution of elasto–plastic problems by finite element method. Program ASTRA." , Moscow,Preprint of IPM AS USSR, No. 326, 1988, pp. 1–63 (In Russian); J. Computer Mechanics (Russia), issue 2, 1991, pp.78–122 (In Russian).

2. Burago N., "Numerical methods for dynamic problems with large elastoplastic deformations", Proc. of FEM–94 (Ed. N.–E. Wiberg), Struct. Mech. Dept. of Chalmers University of Technology, Göteborg, 1994, rep. No. 94:1, 15 pp.